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TABLE OF CONTENTS

Conference Held on Labor Courses in Engineering Schools..... 345
Management Training for Engineers. O. H. Cheney..... 350
Report of Committees of the 1928 Summer School:
Physics Session 355
Electrical Engineering Session 374
Open Questions in the Teaching of Mechanics. S. M. Woodward... 398
The 1929 Summer School. H. P. Hammond..... 404
Necrology:
Charles Allen Wright 406
Items of Interest 408
New Members 409
College Notes:
Tulane University 410

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CONFERENCE HELD ON LABOR COURSES IN ENGINEERING SCHOOLS

A unanimous vote in favor of a resolution urging the S. P. E. E. to appoint an active committee to make a thorough study of how the subject of labor relations can best be introduced into the engineering curriculum, was the outcome of an informal conference of engineering school educators, held on November 2d, in New York City, at the home of Mr. Sam A. Lewisohn, Vice-President and Treasurer of the Miami Copper Company. The conference was called by Dean Dexter S. Kimball, of Cornell, who likewise presided, and was attended by a score of deans in accessible institutions and by several prominent industrialists, including Mr. Owen D. Young, Chairman of the Board of the General Electric Company, Mr. Gano Dunn, President of the J. G. White Engineering Corporation, Gen. R. I. Rees, Vice-President of the American Telephone & Telegraph Company, Mr. O. H. Cheney, Vice-President and Director of the American Exchange Irving Trust Company, Col. John Price Jackson, of the New York Edison Company, and Mr. Lewisohn himself.

The discussion was notable in the emphasis put on the growing importance of the engineer as an administrator of industry, rather than as a technician. The increasing need of engineering graduates with an intelligent and sympathetic interest in problems of labor was the special gist of the remarks made by every industrialist present, and by Mr. Young in his confidential after-dinner discussion of the problems of the General Electric Company in its present expansion program. The address prepared by Mr. Cheney, on the need of engineers better equipped for administrative leadership, aroused such enthusiasm among those present that it is reprinted in full in the present issue.

In opening the discussion, Mr. Lewisohn gave a number of instances from his own experience and that of others, including Mr. Herbert Hoover, of the difficulty of finding engi-

neering executives with trained ability to handle the human relations in their work. He pointed out that while it may be true that leaders are born, not made, yet there are many born leaders not exercising their qualities because they are not trained in, or really interested in, organization problems. He urged that besides having the subject of labor relations naturally touched upon in the regular engineering courses, there should also be an integrated and distinct course devoted to it so that the student may at least get "a feel for it." He mentioned certain cases of where executives had failed to receive promotion because of their lack of experience in organizing people.

Mr. Gano Dunn stressed the important social results which would come from "making the engineer more human." He felt that the engineering schools had shifted somewhat from preparing men for engineering as he defined it—"the art of the economic application of science to the purposes of man" —and suggested that room be found in the curriculum for humanizing study by taking out such subjects as advanced physics and similar science courses and putting in their place courses in industrial relations, or "the art of organizing men."

General Rees described the problem of the turnover of young college men employed in the Bell System, and declared that the only way that problem and other personnel problems could be solved was by developing a realization on the part of the engineer that "after all, the man in the problem is the all-important problem," and that the way to bring this about was by "indoctrinating him" before he takes up his life's work. This was echoed by Col. Jackson, who emphasized the importance of a proper start, since "it is easier to teach men at twenty than at forty."

The problems of teaching the subject were then taken up, led by Dean R. L. Sackett, who presented an able paper on the program pursued at Penn State, Dean H. C. Sadler, of the University of Michigan, and Dean E. J. McCaustland, of the University of Missouri, all of whom were most helpful in directing the discussion along practical lines. Dean Sadler

declared that personnel relations study might well be substituted for some of the more specialized technical work for the ordinary student. While engineering educators seem very reluctant to drop advanced courses, he felt it was time for them to get together and overhaul the whole curriculum so that "more broadly trained engineers" could be developed.

In responding to the questions raised, Professor E. D. Smith of the Sheffield School, Yale, described his practical work in the reorganization of businesses, and declared that the principal difficulty in every case was the finding of the right type of executives. Technical knowledge, he found, was easy to get, and "at a discount," but the thing he "could not get at any price was men who knew how to handle men." He felt that the emphasis on precision in the engineer's training was often a handicap in personnel relations, where so little can be precise. His method, used in Harvard and Yale, is to carry into the classroom the kind of experience best obtained "on the job" and supervise it properly. He therefore attempts to reproduce actual conditions into which the students would be thrown. To develop a cultural background on which human relations may be based, each student is encouraged, individually, to become interested in the subject from a broad point of view, and to read widely and intelligently—and to follow this after he leaves college.

Dean C. C. Williams of the University of Iowa, compared engineering education with society in general and referred to the fact that while society has gone far in technology and economic organization, it is lacking in the organization of social relationships, so that engineering education should not be blamed for its difficulties with these intangible problems. He felt that personnel problems should be discussed wherever possible in the regular courses as well as in a special course. He recommended the case method, collateral reading and inspirational talks by industrial leaders.

The point that provoked the livest discussion was the question as to how much of the content of a good labor relations course could be interspersed in other courses. Several speak-

ers emphasized the fact that while this was a desirable supplementary method, it could under no circumstances be considered a substitute for a thoroughly integrated course dealing with the subject in a basic way.

The same point was made by two guests not connected with engineering schools, Dr. Lee Galloway of the Ronald Press, and Professor Herman Feldman of Dartmouth. The former compared the problem to that of introducing a course in ethics in a new school of retailing and suggested, from that experience, that a course in personnel relations should be given and developed so as to become a center from which the subject spread into other courses. Professor Feldman, citing the problems of teaching similar subjects in schools of business, declared that the only adequate way to present them was through an organized course which could present a "complete picture and a philosophy" of personnel relations.

The second point regarded as of utmost importance was to find means of interesting the faculties of engineering schools in this newer need for the inclusion of special courses on labor relations and of interspersing it in the other courses as well. Dean E. A. Hitchcock of Ohio State, declared that the first problem in developing personnel relations study was to "educate the faculty" to giving up some courses to which they tend to cling.

Several speakers urged that the discussion at the conference, found so profitable by those present, be brought to general attention through publication in the journal of the S. P. E. E. and in special reports, leading to the resolution that a special committee be appointed by the S. P. E. E. to canvass the whole subject.

Among those who contributed significant points to the discussion were: Professor W. H. Kenerson, Brown University; Professor C. F. Scott, Yale University; Professor Jos. W. Barker, Mass. Inst. of Technology; Dean H. J. Hughes, Harvard University; Professor H. P. Hammond, of the S. P. E. E.; Dean G. B. Pegram, Columbia University; Professor Joseph Roe, New York University; Dean A. M. Greene, Prince-

ton University; Dean Louis Mitchell, Syracuse University; Dean Milo S. Ketchum, University of Illinois; Dean Anson Marston, University of Iowa; Dean O. M. Leland, University of Minnesota; Professor F. L. Bishop, University of Pittsburgh; Professor Ely, Carnegie Inst. of Technology; President C. R. Richards, Lehigh University; Professor J. R. Bangs, Cornell University.

MANAGEMENT TRAINING FOR ENGINEERS *

BY O. H. CHENEY

Vice-President, American Exchange Irving Trust Company, New York

I am neither an educator nor an engineer and that, I presume, makes me qualified to discuss the improvement of educational methods and of engineering practice. But I do not wish to undertake any such discussion—I should like, rather, to convey to you a few impressions from the other side of a banker's desk, which, you may feel, have some bearing on both of these subjects.

The banker may not have time for much reflection but in the course of year after year of day after day activity, he is at least able to achieve some cumulative observations which arrange themselves into some sort of perspective of business. The banker is in a position to see business in action, not merely one business but that amazing variety which makes up our economic life. He is able to see certain trends as they are developing—to sense needs before they become urgent—frequently to become aware of danger before it becomes serious.

In my actual and intimate contact with different types of businesses, two most significant phenomena have impressed themselves on me more and more every year. The first observation is of the changing type of man with whom I have to deal—the changing type of business executive. The second observation is naturally of business methods—the changing practice of management technique.

In the history of business, those who have directed business, been concerned with the actual management of the actual operations, have come from various sources. At different stages in the history of business, very often one source or another has been predominant. At one time, particularly during the era prior to the development of the big corpora-

* Presented at Conference of Engineering Educators, New York, November 2, 1928.

tions, the managing executives, usually also the owners, most frequently came from craftsman origins. They managed the business because they knew their particular business—probably they had grown up in it. Nowadays the dominant types of executives come from those trained in law, in banking, in engineering or those with successful experience in selling. The specialized executives more and more become the general managing executives. This may be an age of specialization but all around us the specialist is leaving his specialties behind.

Even those executives who are concerned with some specific phase of their business, very frequently have to give up real technical practice and become more and more involved in purely administrative functions. The engineer gives up the sliderule and the blueprint for the control board and the sales map.

Business—our national prosperity—depends more and more on the efficiency, the smooth operation, of our huge production machinery. The increasing fierceness of competition—both the old competition and the new competition between industries—means competition in efficient production. We have been saying very frequently in the last year or two that the biggest economic problem of today is distribution. I think we shall soon discover that this is an error—the biggest problem is still efficient production—and will be for many years to come.

For this reason more and more of the executives I meet are men with engineering training. More and more are the business owner, the investor and the banker turning the management of industry over to the engineer—and the engineer must not fail. He must be prepared for his new task—the whole task. He must not permit himself to enjoy the thrill of management without facing all of its difficulties.

Business expects of the engineer, who undertakes executive management, security of investment and maintenance of reasonable profits. It is the function of every executive to be vigilant eternally in seeking out and removing all conditions or tendencies which may threaten profits. Every phase of management must be based on this principle and no phase

may with impunity be neglected. Sound management must include not only the management of machines, materials, methods and money, but also the management of men.

I stress men because time and again I have seen otherwise good management fail in its administration of personnel relations. Good machinery, good technical methods, intelligent financing, energetic selling—I have seen all these turned to nought by poor management of men. I have seen, too often, labor troubles become a major cause of inadequate return on capital and enterprise. By labor troubles I do not mean only the spectacular troubles of strike and lockout, but the invisible labor troubles which are much more sinister because they are unseen. Strikes have taken an enormous economic toll in this country but it is a shoeshine tip compared with the loss due to invisible labor troubles—to friction, to imitation, to indifference, to sullenness and to carelessness.

In a great many businesses there is an executive whose especial function it is to deal with personnel relations. Of course, this is not the solution to all personnel problems—and those executives, who have ever been under the illusion that it is, have sooner or later been disagreeably awakened. Certain personnel relations are so continuous, so important and of such a nature that they are best handled by assigning them to a specialized executive. But relatively few of the relations between men and management can be segregated like research or sales or finance. No executive can turn over to another his individual attitude and his individual relationship with the men under him and with the employe body as a whole. Real knowledge of sound management principles as applied to personnel relations must be a part of every executive's equipment and the daily practice of them a vital part of every executive's functions—from the chairman of the board of directors down to the youngest straw boss. No man can turn over "being human" to another man.

And it is not merely a matter of being human—it is the problem of being intelligently human. No man is born that way, although most men who have enough in them to achieve executive positions of responsibility have the inborn qualities

upon which this essential ability may be built. The unfortunate fact is, however, that the necessity for applying sound management principles to personnel relations has been generally unrecognized. Not one of the major groups which have at one time or another in our industrial history held the dominating managerial positions has a record in personnel relations of which it can be particularly proud. The old craftsmen-executive has naturally tended to watch too closely the development of his pioneer machinery; the lawyer has immersed himself in the obtuse problems of corporate practice; the banker has concerned himself too much with safe financing and the distribution of profits. Shall we allow the engineer to lose himself entirely in the problems of production methods, purchasing control and sales budgets?

No—would it not be better for the engineer to learn from the errors of his predecessors? The reason why the executives of other origins did not succeed in personnel management is because they did not have the proper approach by experience and training. For a time, during the war, it looked as if executives would come into business from another source with such experience and training—from the professional group of what might be called social workers. But because of the inadequacy of their other training and experience for industry, this trend practically ended after the war.

Now, with a growing proportion of engineers filling a growing proportion of executive positions, these problems have become the engineers'. Fortunately the technical background of the engineer is admirably adapted to harmonious integration with the best principles of personnel management. The engineer brings from his professional training and practice sound and practical logic, accuracy and objective judgment.

The question arises, "Why cannot the engineer pick up the principles of personnel management as he goes along?" The answer is the question, "Is he expected to pick up the principles of engineering as he goes along?" No, that is no longer the case. You try to give him a sound grounding in the principles of dealing with machines, materials and, to some extent, even money. Why not also men? The fact is that

an engineer is expected to know physics and chemistry and mechanics—and a good deal about their specific applications when he enters business.

It seems most logical for the engineer to learn also the principles which govern human relations in industry at the same time as he studies the principles of thermodynamics or economics. He should learn to recognize stresses and strains in management as well as in machines and materials. And I feel sure that you gentlemen concerned with engineering education can solve the problems of teaching your students these principles—and many of you already have made satisfactory progress towards such a solution.

REPORTS OF COMMITTEES OF THE 1928 SESSIONS OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS

The following reports were prepared by committees of the members of the two sessions of the Summer School for Engineering Teachers of 1928. Each member of the conferences served on one or more of the committees. The membership also included, as a rule, one advisory member selected from the staffs. The reports were prepared and presented to the sessions in preliminary form and were then discussed. In some instances the reports were adopted as originally written. In others, the committes were instructed to modify the reports in accordance with the majority vote of the members. The reports were then altered by the committees and submitted for final adoption. In most instances they were adopted unanimously, though in some cases members dissented from the majority opinion and a vote on the division was taken.

It was the sense of the conferences that the preparation of reports did not constitute an attempt to legislate on matters relating to the teaching of physics or electrical engineering but merely to record the majority opinion of the groups and to serve as a stimulus to further study and discussion. The reports are published to that end.

REPORTS OF COMMITTEES OF PHYSICS SESSION

REPORT OF COMMITTEE NO. 1 ON CONSIDERATION OF SYSTEMS OF UNITS IN MECHANICS AND IN ELECTRICITY AND MAGNETISM FOR STUDENTS OF ENGINEERING

The following report represents the opinion of the majority of this committee with regard to the teaching of units in beginning physics to students of engineering.

1. We recognize the necessity of teaching both the C.G.S. system and the British Engineering system of units.

2. It is recommended that we refrain from the active use of metric gravitational units in dynamics.

3. It is recommended that we refrain from the active use of the British Absolute system in dynamics.

4. It is agreed that we use the pound as the unit of force. Where an exact definition is required it shall be defined as 1/2.204662 of the international kilogram of force.

5. It is agreed that the unit of force involves a consideration of the dynamical unit of mass, meaning that amount of material which may be accelerated at the rate of one foot per second per second by this force.

6. It is agreed as to the desirability of naming this dynamical unit of mass but at present no suitable name has been agreed upon.

7. It is agreed that as a first approximation, sufficient for ordinary engineering practice, the value of g and the weight of any given body may be regarded as independent of locality.

8. It is recognized that the international electrical units are intended to be certain definite multiples or sub-multiples of the C.G.S. electromagnetic units and are so nearly such that the differences therefrom are negligible in engineering practice.

9. It is recommended that the C.G.S. electrostatic units be ignored except in teaching the fundamental principles of electrostatics.

10. It is recommended that the prefix *ab* be added to the names of the international electrical units to designate the C.G.S. electromagnetic units, and that the prefix *stat* be added to the names of the international units to designate the C.G.S. electrostatic units.

11. We believe that greater uniformity in the use of units might result from a joint conference of representative teachers of physics and of engineering subjects. We suggest, therefore, that this conference recommend to the Executive Committee of the Society for the Promotion of Engineering Education that such a conference be held, and that the results of

their findings be presented at an early annual meeting of the Society for discussion and action.

Respectfully submitted,

W. N. St. Peter, *Chairman*,
J. O. Hamilton,
F. B. Haynes,
W. E. Wheeler,
Wm. S. Franklin, *Adviser*.

REPORT OF COMMITTEE NO. 2 ON PURPOSES AND TREATMENT OF HOME PROBLEM WORK

The Committee on Purposes and Treatment of Home Problem Work submits the following report:

Purposes:

1. To fix in mind the fundamental principles of physics by means of their application to concrete cases.
2. To develop ability to do analytical thinking.
3. To develop ability to apply principles quantitatively.
4. To compel a recall of material already studied.
5. To enable the student to experience the satisfaction which accompanies the completion of a definite piece of work.

Types of Problem.

The types of problem which seem well adapted to the purposes stated above are:

1. Simple numerical problems which can be solved by obvious substitution in formulas.
2. Numerical problems which cannot be solved by mere substitution in formulas.
3. Problems which require a symbolic solution.

Methods of Treatment.

The details of the methods used must be worked out by each department of physics. Nevertheless, the committee believes that the following principles underlie an efficient method of treating the home problem work.

1. Problems to be assigned should be chosen carefully to fulfill the purposes stated in the first section of this report.

2. The assignment should consist, whenever it is feasible, of more than one type of problem.
3. The problems of each assignment should be arranged in order of increasing difficulty.
4. Solutions of problems, if handed in, should be corrected and returned.
5. Data for problems should be chosen to minimize arithmetical calculations.
6. All assignments should contain review problems as well as advance problems, the number of each depending upon the nature of the work.
7. We believe it is desirable to give to the students the answers to problems, except to problems of very simple character.
8. In general, home problems should be assigned in connection with each lesson.
9. Ample opportunity should be given for discussion of problems with which students have experienced difficulty.
10. Some problems should be assigned in which particular attention is given to significant figures.

Respectfully submitted,

W. H. STANLEY, *Chairman,*
JOSEPH A. COOLIDGE,
ALDUS FOGELSANGER,
PARKE B. FRAIM,
G. E. GRANTHAM,
O. M. STEWART, *Adviser.*

REPORT OF COMMITTEE NO. 3 ON EXAMINATIONS AND TESTS

Your Committee on Examinations and Tests presents the following report for consideration and hopes that the members of the Conference will add to any value that it may have by a full discussion of its various points and by suggesting improvements.

Final Examinations.

1. The committee believes that the most important educational value of the semester or final examination in physics is that it requires the student to review the entire subject in a comprehensive way and thus aids in giving him an understanding of the relationship of its parts as well as a knowledge of it as a whole.
2. The committee believes that the satisfactory completion of a final examination gives a sense of achievement to the student, and, in that way, serves as a means of stimulation.
3. The final examination should also, of course, serve as one of the means of measuring the student's achievement. The committee recognizes that the final examination, as usually given, is not an altogether accurate method of measurement, but believes that its value is nevertheless sufficient in this respect to warrant its retention.
4. For the above reasons the committee favors the use of the final examination.
5. The committee favors requiring all students to take the final examination in the first course in physics. (The vote of the session on this section was 28 in favor and 9 opposed.)
6. The committee feels that a weight of at least one-third should be given to the final examination in determining semester grades.

Periodic Tests.

7. Written reviews serve the same general purposes as the final examination and in addition give the student a review while the subject is still fresh in his memory. They also give both the student and the instructor a frequent check on progress. For these reasons the committee is strongly in favor of frequent written tests throughout the first course in college physics.
8. The committee believes that the intervals between written reviews should in general be from two to three weeks.

9. The committee believes that, insofar as possible, written reviews should be so timed as to cover fairly distinct divisions of subject matter.

Daily Reviews.

10. The committee commends the practice of giving brief daily tests, in written form, and suggests that the first five or ten minutes of the recitation period be used in this way.

Forms of Examination; Kinds of Questions.

11. The committee has given consideration to the form of the final examination and has discussed the relative merits of the commonly used type consisting of written statements of definitions and principles, description of processes, problems, etc., and also to the newer, so-called, *objective* type of examination. The committee recognizes many limitations of the traditional form of examination and specifically its inaccuracy as a means of measuring achievement. The committee does not feel, however, that the traditional form of examination should at present be abandoned in favor of the newer form. It is disposed to recommend the experimental trial of the newer form, as exemplified by the Iowa Achievement Examinations in College Physics, during the ensuing year either in conjunction with or possibly as a substitute for the older form of examination. The committee recommends that if this be done reports upon the results of the trial, including comparisons between the use of the two forms of examination and expressions of opinion, be sent to the S. P. E. E. office for compilation and distribution.

12. The committee learns that a report on the trial of placement examinations by a considerable group of colleges is now in preparation and therefore does not wish to express any views on the use of the objective form of examination at the beginning of the first course in physics until there has been opportunity for study of this report.

13. As to the traditional form of examination, the committee believes that it should include the several kinds of questions now generally employed: written statements of definitions, principles and laws; descriptions of instruments, experiments, devices, etc.; solution of problems; and derivation of formulas. The committee recommends that the solving of problems be an important part both of the final examination and of periodic written tests. Some of the problems should be brief, involving a single principle or law, while others should require the student to bring to bear his knowledge of more than a single principle or law. The committee would emphasize the importance of the latter type of problem since it requires the exercise of powers of reasoning as well as of memory.

The committee would recommend that, with rare exceptions only, questions of final examinations relate to the more basic and fundamental laws and concepts of physics.

Accuracy of Statement and of Computations.

14. The committee recognizes that the teaching of principles is the primary purpose of the first course in college physics and that facility in computation is relatively of secondary importance. It believes however that the habit of accuracy of statement and of computation should be developed throughout the course. This should be reflected in a requirement of accuracy in examinations. To this end accuracy should be taken into account in grading examination papers. The committee recommends that examination papers showing throughout a lack of accuracy either in statement or numerical computation should be rated as failures.

Length of Time Allowed for Examinations.

15. The committee has considered the length of time that should be allowed for a final examination in college physics but feels that this is largely controlled by the

type of examination or by local practice and does not care to recommend any specific time allowance. The committee believes, however, that whatever the time, the contents of the examination should be such as to avoid compelling any substantial portion of the class to work under the pressure of insufficient time.

Respectfully submitted,

C. L. BRIGHTMAN, *Chairman*,
C. J. CARDIN,
F. W. HAM,
G. J. MARQUART,
F. RAWLINSON,
A. E. WHITTAKER,
H. P. HAMMMOND, *Adviser*.

REPORT OF COMMITTEE NO. 4 ON FUNCTION OF LABORATORY WORK AND ITS COORDINATION WITH CLASS ROOM WORK

Your Committee on Functions of Laboratory Work and Its Coordination with Class Room Work reports as follows:

Objectives.

1. The primary aim of laboratory work in connection with a course in general physics is to elucidate fundamental concepts and principles of physics and to fix them firmly in the mind of the student.
2. Secondary objectives of such laboratory work are to stimulate the student's interest in the study of physics through personal experimentation, to inculcate the habits of careful observation and of quantitative thinking, to teach proper methods of measurement, computation, and report-writing, and to assist in developing initiative.

Methods.

3. Each experiment should, therefore, illustrate directly a definite concept or principle of physics. Experiments which teach merely the use of instruments are, in general, undesirable.

4. A limited use of qualitative experiments which clarify fundamental concepts is recommended.
5. Quantitative experiments should be designed to allow fairly precise measurements. The student should be taught to form some estimate of the accuracy of his work. Results should not be accepted unless reasonably accurate.
6. No experiment, whether quantitative or qualitative, should be considered complete without a clear, concise report, in tabular form if possible. The report should also contain answers to leading questions on the theory underlying the experiment.
7. The apparatus should be as simple as is consistent with desired results. It should never be so complicated as to obscure the principle involved. Its workmanship and condition should be such as to inspire the respect of the student.
8. Experiments which are sometimes used in lecture demonstrations but which are best appreciated when performed by the student individually, should be set up in the laboratory. They should be of such nature as to stimulate the interest of the student by appealing to his curiosity, while at the same time illustrating important principles. As examples we mention the formation of a variety of spectra and of Newton's rings, gyroscopic action, and other experiments of the museum type.
9. As a means of developing initiative, the student should work alone whenever possible. Laboratory work should develop the ability to understand oral or written instructions, to carry out such instructions with the apparatus provided, and to reason from cause to effect.
10. The instructional staff of the laboratory should be large enough to give adequate supervision. No more than fifteen students should normally be assigned to each instructor. Use of undergraduate assistants as instructors is deplored. We believe that the quality of

instruction in the laboratory should be equal to that in the classroom.

11. The laboratory work should always be closely coordinated with the lectures and recitations. An experiment illustrating a certain concept should follow, rather than precede, the discussion of that concept in lecture and recitation, in order that ideas gained thereby may be reenforced in the laboratory.
12. It is desirable that the course in general physics be supplemented in the following year by a laboratory course, each experiment of which may involve several physical concepts and principles. Such a course should require students to recall the work of the preceding year, and it may be arranged to place somewhat more emphasis on methods of measurement and on discussion of accuracy of results.

Respectfully submitted,

WILLARD E. LAWTON, *Chairman*,
R. B. DOW,
J. C. GRAY,
F. M. HATCH,
F. F. PIPER,
O. M. STEWART, *Adviser*.

REPORT OF COMMITTEE NO. 5 ON FUNCTION OF AND RELATIVE TIME FOR LECTURES, RECITATION AND LABORATORY PERIODS IN PHYSICS, AND PREPARATION THEREFOR BY THE STUDENT

Owing to the local conditions under which the subject of physics must be taught in the different institutions, your committee has found it impossible to lay down definite regulations for the teaching of physics. Therefore it merely offers the following suggestions, with the hope that they may be of benefit and may lead eventually to greater uniformity.

1. That new concepts and fundamental principles be introduced, first, in the lecture.
2. That new concepts and principles be introduced through simple, qualitative demonstrations.

3. That lengthy derivations of formulas be omitted from the lecture in so far as possible.
4. That the recitation be used to develop more fully, and fix more definitely, the concepts and principles introduced in the lecture.
5. That the recitation consist mainly of class discussion and specific problems.
6. That it is desirable to have one recitation for each lecture.
7. That it is desirable to have one two-hour laboratory period for each lecture, or one three-hour laboratory period for each two lectures.
8. That the instructor in charge of a section should arrange consultation periods with his students.
9. That the relative time devoted to the preparation for lecture, recitation, and laboratory must necessarily vary with the school and course to such an extent as to make it inadvisable to recommend a definite mode of procedure.

Respectfully submitted,

FRED G. PERSON, *Chairman,*
W. F. BROWN,
A. W. DOLL,
H. E. ERSKINE,
C. F. FERRY,
PERCY HODGE,
W. J. DRISKO, *Adviser.*

REPORT OF COMMITTEE NO. 6 ON COORDINATION OF PHYSICS WITH OTHER SUBJECTS

The committee is of the opinion that considerable improvement in the teaching in engineering schools could be attained by better coordination of the work of departments teaching related subjects. If in one department the treatment of a topic differs radically from the treatment of the same topic in another department, the student will have difficulty in passing from one department to the other. If concepts are used in different senses in the two departments, the student

will form the impression that one of the departments is inefficient. Physics, being a fundamental experimental science, has many points of contact with other engineering subjects, and it is especially important that the teaching of physics should be well articulated with the teaching of other subjects closely related to it. In this report only a few cases of apparent lack of adequate coordination can be discussed with some suggestions for improvement.

Significant Figures and Powers of Ten.

The contacts between physics and mathematics are so numerous that close coordination is highly desirable. The use of powers of ten for very large or very small numbers and the limitation of calculations to a certain number of significant figures are sometimes taught in freshman mathematics. If the use of these methods could be practised more widely in the solution of problems in freshman mathematics, it would be of great service to the teaching of physics and several of the engineering subjects.

Physics and Calculus.

When physics and calculus begin simultaneously, the student's progress may be greatly facilitated by having the concepts of velocity and acceleration taught in the physics course just when the teacher of mathematics is struggling with the terms first and second derivation. If integration, regarded simply as anti-differentiation, could come early (as it does in some text-books), it could be used by the teacher of physics in deriving formulae for accelerated motion. Also if an elementary treatment of integration between limits could come sufficiently early to assist the teacher of physics in the treatment of moment of inertia, center of mass, and so on, the arrangement might be of much service to the teachers of both subjects. It is of course recognized that even the best of good-will might not make all of these correlations possible.

Moment of Inertia.

The term "moment of inertia" is used with two meanings, namely, as the integral of r^2dm where dm is an element of mass and as the integral of r^2dA, where dA is an element of

area, the first being the sense in which it must be used in physics and in some parts of engineering, and the second the sense in which it may be used in other branches of engineering. It is the duty of the teacher of physics by lecture, laboratory experiment and recitation, to give the student a clear idea of the moment of inertia as the integral of r^2dm. This is the sense in which it must be used in later parts of the work in physics. This is a difficult task even without complicating the problem by introducing the term in the second sense.

Changing the name of one of these concepts might be difficult, but the committee cannot refrain from urging the desirability of such a method of escape from a confusing situation.

The relation between the two terms is a mathematical analogy. This should be impressed upon the student at some stage in his study, and he should be warned as to the possible danger of confusing the two uses of the term. Teachers of mathematics in engineering schools use moment of inertia as a basis for problems in integration. This committee believes that the best place to impress upon the student the difference between the two uses of the term is in the work of the mathematics department. Practice on these problems in the mathematics department will usually come after the introduction of moment of inertia in the physics classes and before its use in engineering. This seems to be the best place to make the distinction, and we would urge that efforts be made to meet the difficulty in this way. Conferences in each institution between representatives of engineering departments, of the physics department and of the mathematics department might be of use in this connection.

But the teacher of physics should always remember that the teacher of mathematics has a task which, in some ways, is even more difficult than his own. Each department in an engineering school should, we believe, make every effort to understand and allow for the difficulties peculiar to related departments. Failure to do so is the cause of much misunderstanding and is sometimes detrimental to the progress of the student.

Electrical Measurements and Alternating Currents.

Practice differs in institutions as to the department in which electrical measurements and the elements of alternating current theory are taught. Sometimes they are taught in the physics department and sometimes in the electrical engineering department. If a good working arrangement has been secured we believe it should not be disturbed, in other cases the matter should be decided by conference between the two departments.

Similar considerations should apply to the teaching of such subjects as Kirchoff's Laws and the elementary theory of the generator and motor.

Thermal Coefficient of Expansion.

The coefficient of linear expansion and several similar coefficients are defined and found on the supposition that the initial temperature is a specific temperature, commonly zero degrees Centigrade or thirty-two degrees Fahrenheit. In calculations involving these coefficients, large errors may be made if one of these coefficients is used to calculate directly the change from any initial temperature to any other temperature; for example, in calculating the volume of a gas at constant pressure or the resistance of a wire. This is especially true if the coefficient is comparatively large, and then it should be used strictly as defined. On the other hand the coefficients of linear expansion of metals, such as steel, are comparatively small. Hence in many practical problems, especially in calculating corrections of steel surveying tapes for atmospheric change of temperature, the coefficient of expansion may be used for direct calculation between two temperatures as if it had been defined and found for these temperatures. Teachers of surveying frequently find that students think they must first calculate the length of the tape at zero degrees Centigrade or thirty-two degrees Fahrenheit. Physics teachers should explain and emphasize the simpler method of calculation when the coefficient is small and the change of temperature small.

The Specific Heats of a Gas.

The meaning of the specific heat of a gas at constant pressure and its specific heat at constant volume and the funda-

mental reason for the difference between them is a point of particular difficulty at an early stage in the teaching of thermodynamics. Teachers of thermodynamics usually assume that students have learned this in their physics. The difference often seems so simple to the teacher of physics that it is not sufficiently emphasized, whereas to the student the difference is often surprisingly difficult. He first gets the concept of specific heat in connection with solids and liquids, where changes of volume are not referred to, and why the volume should come in to bother him in speaking of the heat required to warm a given mass of gas may remain a mystery, even if he memorizes a definition of the term. Not having duly understood, he promptly forgets it. In this connection, the physics teacher should strongly emphasize the connection of the equation with the conservation of energy, reenforcing it with some elementary considerations from the point of view of the kinetic theory of gases. Some well selected problems involving the relation between the mechanical equivalent and the difference between these two specific heats are useful in teaching these concepts.

Respectfully submitted,

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H. C. BROWN,
F. C. FARNHAM,
G. E. GRANTHAM,
V. B. HALL,
A. W. DUFF, *Adviser*.

REPORT OF COMMITTEE NO. 7 ON THE EXTENT TO WHICH MODERN PHYSICS SHOULD BE INTRODUCED IN COURSES FOR ENGINEERING STUDENTS

Your committee appointed to study the place of modern physics in the engineering curriculum reports as follows:

The Content of Modern Physics.

The growth of modern physics has been based on a few fundamental experiments, most of which occurred in the decade from 1895 to 1905. These include the discovery and

isolation of the electron, the discovery of radio activity, the first detection and description of X-rays and the ensuing demonstration of their undulatory properties, and the whole sequence of experiments resulting in the *nuclear* hypothesis of atoms.

Of equal importance with the discoveries themselves has been the formulation of new physical principles involving concepts which not only were more powerful than the older ideas but in many cases were so novel as to be unintelligible to the older school of physicists. The outstanding new theories have been the relativity theory both in its restricted form and in its later generalized statement, and the quantum mechanics in its many guises. Interwoven with these have been new theories of atomic structure, spectral origin, interaction of radiation and matter, evolution of elements, and chemical combination.

The teacher of engineering physics is faced with many difficulties when he contemplates his students and the field of modern physics. In the old phrase, it is "Ars longa, vita brevis," with physics the art, and the time allotted to engineering physics the exceedingly short life. Into a course already crammed to bursting, shall he introduce this new volume of facts and these new ways of considering them? For there is little in the older physics which has been given to engineers which can be omitted without endangering the foundation for the technical studies which follow. And the immediate engineering application of much of modern physics is not evident. This latter consideration, however, carries with it no insurance that the application will never come. As we look back we can see all dynamo-electric machinery in embryo in the researches of Michael Faraday. In the pages of Willard Gibbs, he who tarries and ponders may read the rise of the chemical industry. May not these deep-lying changes in physics presage just as surely far-reaching developments in engineering? The future only can answer with certainty.

Criteria for Adding New Material.

Any solution of our problem in teaching this broad field to

engineering students must involve careful consideration of the goals we hope to reach in the process. These goals include an effective preparation of the student for his ensuing technical study, a widened and a freshened outlook on the physical world, a stimulated curiosity about physical matters, and a slight familiarity with the paths which physicists are following. The older physics is, of course, sufficient for many of these ends and we should hesitate in introducing new material into our courses unless some real gain results.

Electron Theory.

It may be laid down as a general principle that modern physics is to be introduced wherever and whenever it makes the older facts and principles more vivid and more real. In particular the electron theory may be used to great advantage in electrostatics and in electrolysis as well as in some phases of electrodynamics. Even with engineering students one should not pass by the stimulation which comes from a qualitative unifying explanation afforded by the electron theory of metals for such diverse phenomena as thermal and electrical conduction in metals, the Seebeck and Peltier effects, thermionic emission, the Thomson effect, and Ohm's law. An elementary exposition of magnetism as a property of moving electrons may well be included. The electron theory may be used with equal effectiveness in discussing the unity of electromagnetic waves, not as regards their common velocity but as regards their common source in moving electrons.

Molecular Theory.

While the molecular theory of matter is much older than these newer parts of physics, yet the recent developments have brought a certainty and a vividness to the idea of molecules which was lacking. In many parts of physics the molecular behaviour may be utilized in forming pictures of the realities lying underneath phenomena in the large and the student may be led thereby to a more comprehensive view of nature. The distinction between states of matter, the nature of heat and of temperature, the propagation of sound, surface tension phenomena, the diffusion of matter, the properties of gases, the conduction of electrolytes, the ionization of gases

—all these and many more topics may well be presented from the molecular viewpoint though not necessarily to the exclusion of other methods of approach. The simple pictures of ordinary solids which have come from X-ray analysis should be used freely.

Relativity and Quantum Mechanics.

We approach more debatable ground when we consider the teaching of relativity and quantum mechanics. These have affected physicists profoundly both in experimental methods and in philosophical attitudes. Should the physicist attempt to inculcate this changed viewpoint in the engineer? To the engineer as a technician both theories are surely nebulous. Matter in the large need seldom be considered except in the old familiar ways. But for the engineer as an intelligent student of nature some familiarity with these matters is surely necessary. It is doubtful whether teachers of engineering physics can present more than fleeting views of relativity and quantum mechanics but even passing references are valuable in opening the minds of students to broader fields of physical knowledge. Some reference should be made to the variation of mass with velocity, to the merging of the two laws of conserved mass and conserved energy, and to the conflicting corpuscular and undulatory notions of radiation, if only to shake the complacency of the student and to stimulate outside reading.

Supplementary Course.

The field of modern physics contains much that the engineer should know of, rather than that he should know. It is suggested that the general course in engineering physics be supplemented by a later course in modern physics. The general course must conform, of course, to many technical requirements and must come early to lay the needed ground-work for engineering. The course in modern physics might for the present be regarded as largely informative or cultural and might well be delayed as late as possible. The emphasis of the course should be laid upon the stimulation of reading, and demonstrations and lecture should be designed with this end in view.

The committee recommends that an elective course in modern physics be added to the engineering curriculum in colleges where it is not offered already.

Respectfully submitted,

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ALBERT BALL,
S. M. HEFLIN,
J. P. LITTLE, JR.,
F. V. WENDLING,
A. W. DUFF, *Adviser*.

GENERAL RECOMMENDATION OF THE CONFERENCE

The members of the Summer School for Teachers of Physics, conducted by the Society for the Promotion of Engineering Education have been carefully considering the problems connected with the teaching of engineering students. We believe that one of the greatest difficulties with which we, as teachers of physics, contend is the limited amount of time allotted in engineering curricula to our subject. The median time allotted to the general course in physics in the thirty-six institutions represented here is ten semester-hours. In this time we are expected to cover five divisions of physical science. A very large number of new concepts have to be introduced, and the student should be drilled in these by lecture, recitation, problem work, and laboratory practice until the proper use of them becomes almost instinctive. We should give the student such a clear understanding of the fundamental principles that he can go on with advanced work in applied heat, in mechanics, and in electricity. In addition we should give the student some understanding of the broad principles underlying all physical science and some insight into the extensive developments that are taking place in our field. To do all this with any thoroughness requires more time than is generally available.

We believe that the course in general physics should under no circumstances be less than twelve semester-hours, and hope that engineering schools will generally follow the example already set by some in giving more than twelve semester hours for the teaching of general physics.

REPORTS OF COMMITTEES OF THE ELECTRICAL ENGINEERING SESSION

COMMITTEE REPORT NO. 1 ON COMPREHENSIVE EXAMINATIONS

1. A comprehensive examination is an examination given to the student for the purpose of determining his ability to correlate the principles of subjects covered.
2. We feel that the examination should be taken from a large list of questions and problems covering the essentials of all courses taken.
3. The examination should be drawn up by a representative local board of the engineering faculty giving the examination after a consideration of a large number of questions which might be submitted by some national board.
4. The results of the examination should be reviewed by this same local board and the grades determined.
5. In order that the student may derive benefit from these examinations they should be given long enough before the close of the year that they can be returned and discussed.
6. The national board should consist of engineering teachers representing the various branches and members from the industrial or practical field. They should draw up a large number of questions and submit this list to the colleges desiring to give such examinations.
7. We do not recommend that the results of these examinations be used in determining whether the student graduate or not. Present practice varies in this respect.
8. We believe that this examination would be extremely valuable to the student in that it would enable him to take stock of his progress and emphasize the points in which he is weak.
9. It would reveal to the faculty those subjects in which

instruction is weak as well as those in which instruction is strong.

10. It would reveal the inadequacy of the subject matter in certain courses to meet the requirements of various branches of the industry.
11. It has been suggested that this examination be made national in scope, i.e., administered by a national board for the purpose of comparing different institutions. Your committee is decidedly not in favor of this plan.

Respectfully submitted,

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N. F. RODE,
B. CLARK SHAW,
W. A. MURRAY,
G. V. MUELLER,
R. C. GORHAM,
EDWARD BENNETT, *Adviser*.

REPORT OF COMMITTEE NO. 2 ON TYPE AND SCOPE OF APPLICATION COURSES

The chief aim of this committee was to obtain a consensus of judgment from the members of the conference on the various points involved in the teaching of application courses.

A questionnaire which was formulated from suggestions by Director Wickenden, Professor Harding, and members of the committee, was drafted and submitted to the members of the conference.

Returns were received from representatives of eighteen institutions.

The questions asked and a summary of the answers to each question follow:

1. *Name the application courses and the number of credit-hours of each which are required at your institution.*

Sixty per cent of the schools reported that some application courses were required, the requirement ranging from one three-unit course to four three-unit courses. The requirement of communication and power transmission courses predomi-

nated with railways and electric power plants following. The average time spent on each course was equivalent to one three-unit course.

2. *What are the principal reasons for giving application courses to undergraduates? Number the following in the order of their importance.*

1. *To meet the needs and desires of employers.*
2. *To meet the desires of students for "practical" courses.*
3. *To give individual teachers an outlet for initiative and enterprise.*
4. *To illustrate grouped applications from several fields.*
5. *To stress consideration of engineering economy.*
6. *To arouse interest of students.*
7. *To guide the students in choice of life work.*
8. *To encourage thesis, development and initiative for specialized fields of particular interest to the student.*
9. *To provide adequate training for the industrial, public utility and sales interests of certain students.*
10. *To diversify the staff and to provide for specialists in the staff for technical advice, highly specialized instruction, etc.*

Items four, five, and six of this question were rated as of first importance. Items two and seven came next in importance. These two items were given more first places and if they had been combined into one item, it is believed that this item would have received a rank of first importance.

3. *Do application courses consume time which is needed to do ample justice to the underlying sciences and to the main core of principles of engineering?*

In answer to this question the vote was:

No	16
Yes	3
Undecided	1

4. *Tabulate the application courses offered at your institution and the professional experience of the instructor in each case as far as possible.*

Course	*Experience*
.....	.....
.....	.....

Out of sixty-nine classes reported, twenty-two per cent were taught by instructors having no experience in their subject, thirty per cent by men of one to two years experience and thirty-eight per cent by men having over two years.

5. *Would it be better to expect each senior student to take only one application course and to devote to it a considerable proportion of his time with a view to using it as an introduction to real engineering method?*

The answers were:

No	11
Yes	5
Undecided	2

6. *Should application courses be reserved to a post graduate year and made more professional in scope and character?*

The answers were:

No	11
Yes	5
Undecided	2

7. *How are your application courses taught, i.e., lecture, recitation, problem, or seminar?* (*Uunderscore and discuss if necessary.*)

The methods used seemed to depend upon the subject matter. The combination of lecture, recitation, and problem work was the most popular.

8. *To what extent is mathematical treatment used: little ..... average..... much.....*

The answer to this question was "average."

Respectfully submitted,

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WARD B. KINDY,
FRANCIS J. ADAMS,
E. E. CLARK,
P. S. CREAGER.

REPORT OF COMMITTEE NO. 3 ON CONTENT AND PRESENTATION METHODS IN ELECTRICAL ENGINEERING COURSES FOR NON-ELECTRICAL ENGINEERS

The committee held three meetings of about one hour each following the Summer School sessions of July 9, 10, and 19, 1928.

The chairman proposed that the committee formulate some definite recommendations concerning the subject under discussion and presented the following questions for consideration:

1. When should the course be given?
2. What should be the length of the course?
3. What subject matter should the course contain?
4. How should the interest of the student be stimulated?

Each of these questions was taken up in detail by the committee and after general discussion by the conference, the following recommendations were presented:

1. That the course be given as soon after the physics course as possible, preferably in the junior year.

2. That the minimum course should consist of three hours class work per week, preferably for one academic year, supplemented by at least one-half academic year of laboratory work.

3. That the content of the course should bring out fundamentals, chiefly of machine and system operation, including enough specific applications to maintain the student's interest. In general the details of design can not be emphasized, but the economics of design and application may be included.

4. The student's interest will be stimulated by supplementing the regular class work with talks given by other members of the teaching staff and by specialists from industry. It is essential that experienced teachers be employed for this work due to the special difficulty of the pedagogic problem, and that these teachers be in contact with industry sufficiently to provide abundant application material. The committee believes that the project feature described in Professor A. E. Knowlton's paper "Courses in Electrical Engineering for

Students Other Than Electrical Engineers," is a desirable method of stimulating and maintaining the student's interest. This paper gives in considerable detail features regarding the administration and content of the very comprehensive course given at Yale University for non-electrical engineers.

The committee has requested Professor Knowlton to approach certain industrial associations to obtain data for problem and project work in these courses. It is expected that this material will be available for institutions or individuals interested.

C. C. WHIPPLE, *Chairman*,
K. L. WILDES,
H. W. ANDERSON,
P. S. CREAGER,
W. E. LOVELL,
N. L. TOWLE,
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C. W. RICKER,
A. E. KNOWLTON, *Adviser*.

REPORT OF COMMITTEE NO. 4 ON DESIGN COURSES

The Committee on Design Courses in attempting to clarify conceptions of the function of design courses in electrical engineering has taken *Design* in its broadest sense as the process of creating, and has emphasized the engineering aspect of the problem at hand.

Society looks increasingly to the engineer for the solution of its problems. The engineer must to this end be grounded qualitatively in the underlying principles of many sciences and quantitatively in the technology of his special field. Engineering educators may be congratulated upon the fact that society today seldom questions the ability of an engineering graduate in the technology of his chosen field.

On the other hand, it is commonly stated that the engineering graduate is narrow. If the criticism be justified, it is justified on the basis that the engineering graduate has in general small knowledge and appreciation of underlying prin-

ciples in social science, in commerce, in industry, in law, or in finance. Yet, in seeking a balanced solution to a project, the engineering graduate must use all of the principles in such related arts as apply. In looking to the engineer, society may reasonably expect to find this breadth of vision.

The committee submits that a "Design Course in Engineering" administered under a single guiding head and administered so as to secure cooperation with the specialists in whatever arts or sciences are involved in the commercial success of a project, may be made of peculiar value in such necessary development in the graduate engineer.

Finally, in submitting recommendations on "Design Courses" the committee wishes to acknowledge its indebtedness to the inspiration of a number of papers presented during this Summer Conference, and especially that of Mr. R. E. Hellmund.

The Committee recommends that:

(1) The "Course in Electrical Engineering Design" be concerned with the *balanced application*, quantitative so far as possible, of such *underlying principles* of whatever sciences related to a creative project as shall tend to insure its commercial success.

(2) The "Course in Electrical Engineering Design" be requisite and offered continuously from the time of segregation in electrical engineering.

(3) The designation of the so-called "Design Course" in electrical engineering be appropriately qualified to convey the extent of its *engineering* "design" content.

The Committee suggests that:

(1) Through cooperation with the Departments of Civil, Chemical and Mechanical Engineering a program be formulated whereby a "Course in Engineering Design," common to all engineering students, may be offered from the time of matriculation until the time of segregation in their specialized engineering fields.

(2) The "Course in Engineering Design" should offer simple, elective design projects selected to emphasize elements

of economics, production, marketing and the like, in the respective branches of engineering. The minimized technical content merely tends to promote judicious segregation.

(3) An "Engineering Design" organization should be developed within the faculty and definitely charged with the administration of such design project work.

Respectfully submitted,

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W. A. CURRY,
J. D. OWENS,
R. E. HELLMUND,
H. P. TUCK,
C. C. WHIPPLE.

REPORT OF COMMITTEE NO. 5 ON LABORATORY EQUIPMENT AND TECHNIQUE

The information contained in this report has been tabulated from the answers to a questionnaire distributed early in the conference. Replies were received from representatives of thirty-nine engineering schools.

Additional information was compiled as a result of the symposium on laboratory equipment and technique.

The Committee submits the following data from which the reader may draw his own conclusions:

Size of sophomore laboratory sections under one instructor:

2	colleges	limit	number	to	9.
2	"	"	"	"	12.
2	"	"	"	"	16.
5	"	"	"	"	20.

Size of junior laboratory sections:

5	colleges	limit	number	to	6.
7	"	"	"	"	9.
9	"	"	"	"	12.
9	"	"	"	"	16.
7	"	"	"	"	20.

Size of senior laboratory sections:

5	colleges	limit	number	to	6.
10	"	"	"	"	9.
10	"	"	"	"	12.
7	"	"	"	"	16.
5	"	"	"	"	20.

Size of groups in sophomore laboratory sections:

5	colleges	limit	number	to	2.
6	"	"	"	"	4.

Size of groups in junior laboratory sections:

12	colleges	limit	number	to	2.
6	"	"	"	"	3.
15	"	"	"	"	4.
2	"	"	"	"	6.

Size of groups in senior laboratory sections:

10	colleges	limit	number	to	2.
6	"	"	"	"	3.
16	"	"	"	"	4.
3	"	"	"	"	6.

Ten schools reported all laboratory work handled by same men who teach the theory.

Five schools reported no laboratory work handled by the theory instructor.

Time required for measurements course (general average):

Preparation	Laboratory Work	Reports	Total
	Measurement Course		
10	60	40	110 hours
	D. C. Machinery course		
20	80	60	160 hours
	A. C. Machinery course		
25	80	75	180 hours

Completion of experiments:

Student required to complete experiment regardless of time, required in 27 schools.

Student not required to complete experiment if it is not completed in allotted time, in 12 schools.

Check on instruments:

The instructors are responsible for the check on instruments after use in the laboratory period in 20 schools.

Six schools have an attendant in the instrument room.

Six schools report that no check is made.

Five schools have the student sign instrument slips.

Choice of instruments:

Thirty-five schools require students to choose the instruments to be used.

The instructor assigns the instruments in 4 schools.

Laboratory manuals and mimeograph sheets:

Eleven schools report the use of some standard printed manual such as *Ricker and Tucker's.*

Twenty-four schools use brief mimeograph sheets, some in addition to the manual.

Ten schools use comprehensive sheets.

Six schools report no use of sheets.

Special laboratory courses:

Nine schools report giving a course in illumination and photometry.

Seven schools give a course in Communication.

Laboratory group formation:

Nine colleges report the use of group leaders.

Laboratory reports:

Thirty-three schools require individual reports for each experiment.

Three schools use laboratory notebook only.

Two schools require a group report.

Non-electrical laboratory courses:

Twenty-nine schools report non-electrical courses conducted in same manner as electrical courses.

Six schools report a different procedure.

Grading:

Seventeen colleges report grades ranging from 10 to 35 per cent for preparation.

Most schools report approximately equal grades allowed for laboratory work and report writing.

Return of reports:

Thirty-one schools return reports for correction.

Eight schools do not return reports for correction.

Grade penalties:

Majority of schools use grade penalties to keep reports up to date.

Laboratory quizzes:

Thirteen schools give written laboratory quizzes.

Eight schools give oral laboratory quizzes.

Ten schools give work for laboratory quiz.

Seventeen schools give no laboratory quizzes.

When laboratory work is given:

Twenty-four schools give the laboratory work in coincidence with the theory.

Fifteen schools give the laboratory work after the theory.

Laboratory work credit:

Thirty schools count the laboratory work separate from the theory.

Nine schools count the laboratory work with the theory.

Laboratory equipment:

Sixteen schools report machines are moved about as desired.

Seventeen schools report machines are permanently mounted.

Six schools report machines are semi-permanently mounted.

Thirty-one schools report driving motors connected up by students.

Nine schools report driving motors permanently connected.

Fourteen schools report the use of plug connectors.

Five schools report the use of lug connections.

Six schools report the use of loose wire connections.

Twelve schools report the use of all three methods.

Thirty-one schools report the use of circuit-breakers for circuit protection.

Three schools report the use of fuses for circuit protection.

Four schools report the use of both circuit-breakers and fuses for circuit protection.

Results of Discussion in Symposium

Forty-one men out of fifty voted that the size of D. C. machines should be limited to 10 K. W. as a maximum.

Thirty-three out of fifty voted that 10 K.V.A. alternator is large enough for all A. C. laboratory work.

The vote was unanimous in opposition to the "vertical system" of laboratory squad organization.

The question of standardizing laboratory courses aroused no discussion.

A vote revealed that three schools used two-hour laboratory periods, thirty-four schools used three-hour laboratory periods, and seven schools used four-hour periods.

Special Laboratory Equipment

The following special apparatus was recommended:

Rutgers—Reactance coils, 2.5/5 amps.—110/220 volts, 60 cycles.

Iowa State College—Use Ford steering wheel on rheostats.

University of Pittsbrugh—Special type Prony brake, auto-speedometers.

Purdue—Induction regulator for varying voltage.

M. I. T.—Neon lamp stroboscope.

Oklahoma—Telephone condensers in parallel for condensive load.

Swarthmore—Contactor for transients on oscillograph.

Yale—Special type of instrument panel.

C. A. Anderson, *Chairman*,
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W. T. Lynde,
A. P. Powell,
H. D. Gruber,
C. E. Lansil,
O. E. Edison,
J. E. O'Brien,
H. E. Dyche, *Adviser*.

REPORT OF COMMITTEE NO. 6 ON ECONOMIC ELEMENTS OF ENGINEERING PROBLEMS

In view of the great emphasis placed upon the above subject by representatives of the electrical industry, it is felt that added emphasis should be given the economic side of engineering work in the curriculum of the undergraduate student. The committee recognizes the necessity of considering local conditions in working out the exact method of obtaining this desired result in individual cases. In general, however, it feels that more problems of an economic nature should be used in the fundamental and application courses of electrical engineering. It further recommends that a special course be given in the senior year in which the students would learn the practical applications of such items as capital investment, interest, depreciation, obsolescence, present worth, rates, economic selection, budgets, financial statements, valuation, etc.

Having noted the present lack of prepared case and problem project material the committee has conferred with representatives of several of the industries and found them anxious to cooperate. It is suggested that the officers of, or a committee representing the Society for the Promotion of Engineering Education communicate with several selected companies of the manufacturing, electric power, and communication groups to formulate a system of collecting and distributing problem material of this character to the members.

Respectfully submitted,

F. H. PUMPHREY, *Chairman*,
J. L. ELLIS,
P. C. SMITH,
A. L. TAYLOR.

REPORT OF COMMITTEE NO. 7 ON TEACHING THE FUNDAMENTALS OF ELECTRICAL ENGINEERING

The teaching of the fundamentals of electrical engineering has been discussed before this Conference from several angles. From the maze of material, the committee selects the following as representing some of the main conclusions to be drawn:

1. The term "fundamentals" is not uniformly used or un-

derstood. The amount and kind of material to be included appear to vary widely. However, there does appear to be a common core in those topics usually taken up in an introductory course in electrostatics, electric currents and circuits, and magnetism.

2. It has been suggested in the committee that the material might better be termed "essentials" and the term "fundamentals" reserved for the relatively few cornerstone facts or relations. But the term "fundamentals" is so commonly used to cover both fundamentals and essentials that it would be somewhat academic to insist upon a distinction which popular thought fails to recognize.

3. More important than the exact determination of the material to be included is the statement of the way in which this material should be presented to students. The committee has gathered some notions as to objectives, also some as to methods.

4. The primary object in teaching the fundamentals of electrical engineering should be to develop a mastery based on thorough understanding, or in the words of various speakers before the Conference "to develop creative ability" or "to develop sound habits of work and thought." That teacher fails who is satisfied with developing the student's ability to work type problems according to model solutions that have been demonstrated. Distinction must be made between mechanical skill in applying formulas, and a mastery based on understanding, and the more complete mastery should be the objective even though many students may appear to be satisfied with the skill in applying formulas.

5. To illustrate the objective we may contrast a student who depends mainly upon formulas with one who depends on a mastery of the experimental facts and other material that may produce the formulas. The difference has been excellently brought out by B. G. Lamme in the statement which is quoted below. (Appendix.)

6. It is important to recognize that an experimental fact or observation is one thing and that the form in which this fact is described or stated is another thing.

The form usually depends upon the arbitrary definition of technical terms, upon arbitrary choice of algebraic conventions, and sometimes upon some geometrical image which is wholly a matter of invention. We have invented images of fields filled with lines, of magnetic properties concentrated at poles, etc. No student can be master of a subject until he clearly recognizes the arbitrary character of such definitions and conventions, and the artificial character of such images. Probably it is in this respect that our common introductory treatments are most at fault.

7. It is desirable that the field of electrostatics, electric currents and circuits, and magnetism, be developed as a logical whole, insofar as this has been shown to be possible. One paper before this Conference has dealt with this point and two papers have dealt with the possibility of using a single system of units throughout.

8. It is desirable that the symbols used for electric and magnetic quantities conform to the Standardization Rules of the A. I. E. E.

Appendix

Quotations from B. G. Lamme, *Journal of the A. I. E. E.*, Sept., 1921, p. 734.

"In my own work at college when I took up a course in mechanical engineering, the professor at the head of the department, S. W. Robinson, had a tremendous reputation among the boys as a man who knew practically everything. In other words the general feeling was that he was a wizard in engineering matters. Naturally, hearing such things, I at first held the same opinion. However, as I got to know him better (and eventually I was very close to him in engineering matters) I acquired an entirely new opinion of him. To my surprise, I found that there were a vast number of subjects about which he knew little or nothing, but nevertheless, on such subjects he could reach conclusions quickly and reliably. For example, in endeavoring to find the source of this ability and also how he got at things, I devised from time to time a number of special problems which I sprang on him on suitable occasions, usually in private. On such problems I had done considerable work and had encountered some difficulty which

was the occasion for presenting the matter to him. I found that in practically all cases, when I first presented a problem to him, he knew practically no more about the subject than I did, or even possibly less, but that almost invariably after a little study, he could solve the difficulty for me and explain it to me clearly. In getting at how he did it, I came to the realization that he simply relied on a few fundamental principles and that he brought these to bear directly on the solution of the problems I put up to him. In many cases, I had also gone over the same fundamental principles, but had no realization to what extent they could serve as tools for handling difficult work. Gradually in watching Professor Robinson's work I came to the knowledge that his real strength did not come from any broad general fund of information, but rather from the fact that he had apparently a limited amount of information of a sort from which he could construct almost anything he wanted. This gave me an entirely new idea of the meaning of education. With him, it was a case of having a few general purpose tools, which he could use in all manner of ways to construct a desired result, whereas, compared with him, many so-called educated men had a vast collection of tools practically none of which they knew how to use."

H. M. CROTHERS, *Chairman*,
H. S. RUSH,
W. A. CURRY,
H. M. JENKINS,
W. R. WORK, *Adviser*.

REPORT OF COMMITTE NO. 8 ON ORIENTATION AND PLACEMENT OF COLLEGE GRADUATES

The committee at its first meeting considered the methods at present used by the various colleges in orienting and placing their students. Three different practices were found to be in use as follows:

The first and most common practice involves no organized plan. The student makes his own choice aided only by conferences with faculty members and such interviews as he may chance to have with industrial representatives who come to the college in search of student employees.

Second, a practice in which the freshman student is aided in orientation by a system of lectures given by representatives

of each department in the school. Placement of the student is then obtained partly by aid of the faculty and partly through visits of representatives from industry. In this matter, however, there seems to be no well developed plan.

Third, orientation and placement through the aid of a full-time personnel officer who studies and recognizes the various types of work in the industry, studies the student by tests, conferences, and personality ratings, and then attempts to place the student where he will best fit. In this connection some of the members of the committee expressed the opinion that the particular company with which the student started did not matter much, but that it was very important to have the graduate orientated functionally as to sales, design, operation, research, etc.

In regard to the suggestions submitted to the committee by Director Wickenden, this committee decided that with the active solicitation of many employers and with the development of organized personnel systems in colleges it would be well for the college officials to bear in mind the fact that they should bring the student to an understanding of the more important factors upon which his choice and decision should depend and should cause him to realize that the actual responsibility for and the results to be accomplished by that choice should lie with the student himself. In other words, the work of a college personnel department should be conducted so as to enable the student himself to make a selection not only of a particular vocation, but also of one particular position from among those available. Having made such a choice it should be the student's task to sell himself as the best available candidate for that particular position.

Your committee believes that student personnel supervision for upper classmen can be handled more effectively by those officers who have had intimate contacts with the particular student rather than by a special officer not intimately acquainted with the student. We, therefore, recommend departmental supervision, rather than supervision by a single officer for the entire school.

In giving the student information regarding employment

relations at the various companies, the college personnel officer should act toward the student as a banker or a consulting engineer would act towards a client seeking investment advice.

After recommending or placing a particular student with a given company, the college personnel officer should not disturb the relations just established by making new offers to the engaged student without first conferring with the employer and securing his advice as to the situation.

After due time, the college officer could with propriety and with mutual advantage make follow-up inquiries regarding the degree of satisfaction on the part of both employer and employee. When dissatisfaction arises in a given situation the student should report the facts to the personnel officer, who after making a careful investigation, can advise as the occasion demands.

If the college has, during the student's course, instilled the proper attitude of mind toward education, but little encouragement for continuing educational activities after graduation would be necessary. Aid should be given by the college upon request in accordance with the existing conditions or suggestions by personal letters sent on particular occasions. The college should through its publications keep graduates informed of new fields of activity which it undertakes. Alumni publications generally serve this purpose.

This committee heartily endorses the suggestions given by Dean Sackett in his paper on the "Ethics of Employing Engineering Graduates" which suggestions were quoted by Mr. Coler in his discussion of engineering graduates in industry.

Respectfully submitted,

For the Committee,

E. H. FLATH, *Chairman.*

REPORT OF COMMITTEE NO. 9 ON THE DEVELOPMENT OF THE ELECTRICAL ENGINEERING TEACHER

On Thursday, July 19 this committee submitted a questionnaire to forty persons. Twenty-two answers have been received to date. A summary of the answers follows:

(The numbers in parentheses indicate the number of definite answers given. The capital letters preceding the statements refer to the initials of the men on the committee who submitted the questions.)

W–1 The most important incentive to which to appeal for the development of electrical engineering teachers seems to be: "Increased enjoyment in one's work and satisfaction in its results."

The next important incentive: "Ambition for personal advancement in the profession."

Third: "Desire to do creative rather than high grade routine work."

Of apparently equal weight and of fourth importance, the four following:

(*a*) The sense of artistry and self expression.

(*b*) Improvement in the status of the electrical engineering teacher.

(*c*) Increased compensation.

(*d*) Desire to keep out of the rut.

W–2 (7) Enjoyment, assimilation of personal experience, and hope for recognition seem to be the chief motivating influences in the self-educating professions, such as include the fine arts.

W–3 (16) Fourteen believe there is a growing importance attached to an earned graduate degree.

W–4 (18) Eight believe a professional degree is in many respects as good as an earned graduate degree.

W–5 (17) Six believe the future path to distinction and advancement of the electrical engineering teacher lies only in the direction of scholarly pursuits.

Six believe it lies in the direction of both scholarly pursuits and consulting practice.

C–1 (21) About two years of practical experience seems to be thought desirable for the electrical engineering teaching applicant.

C–2 (21) Eighteen believe the teacher should keep up his contact with industry.

C–3 (21) Twelve believe the "applications" teacher has more need for outside contacts than the "theory" teacher.

W–6 (*a*) (20) Sixteen believe the younger teachers would welcome supervision if it were worthy of their respect.

(*b*) (17) Nine, wholly or in part, believe the seniors in the teaching ranks are incapable of giving effective guidance.

H–1 (*a*) (10) Nine favor supervision of teaching.

H–1 (*b*) (9) Six believe the head of the department should do the supervising.

H–1 (*c*) (9) Improvement of teaching and improvement of the individual should, collectively, endorse supervision. The reasons are mainly altruistic.

J–1 (22) Seventeen do at least some consulting work.

J–2 (21) Fourteen institutions encourage consulting work.

J–3 (*a*) (13) Five believe consulting improves teaching or technique.

(*b*) (12) Nine believe it increases technical knowledge.

(*c*) (15) Twelve believe it increases insight into engineering economics.

(*d*) (15) Twelve believe it gives insight into psychology not found in text books.

(*e*) (18) Seventeen believe it adds to vision of the future of electrical engineering.

J–6 Consulting may be detrimental if too much is done.

J–7 (19) Eighteen believe consulting practice should be encouraged.

J–8 (18) Eight believe teaching is so big an undertaking that it should not be necessary to engage in outside work, but the need for practical contacts is indicated.

W–8 (14) Eight believe research contributes to the development of the electrical engineering teacher, in part by demonstrating the application of the fundamentals.

B–1 (18) Sixteen believe that research in teaching methods is as important as scientific research.

B–2 (22) Thirteen think it may be unfair to discriminate against the teacher who does not engage in scientific research.

B–3 (22) Twenty believe that the industries should suggest research problems.

B–4 (20) Six believe that the industries can decide what constitutes a good research problem.

B–5 (21) Eighteen believe the industries should lend a reasonable amount of equipment to schools for research purposes.

B–6 (21) Nine engage in research work to some extent.

B–7 (19) Fifteen institutions encourage research.

B–8 (9) Eight believe scientific research work helps to make a better teacher.

B–9 (20) All continually try to find the best possible manner of doing their teaching work.

B–10 (19) Fourteen believe that this is equivalent to doing scientific research work as far as the development of the teacher is concerned.

W–9 (22) Twenty believe that sound standards of self criticism underlie the improvement of the individual.

There is practical unanimity of opinion that the following factors contribute to the sound standards of self-criticism of the electrical engineering teacher.

R–1 Regular habits of outside reading.

R–2 Readiness to confer with the head of department.

R–3 Thorough analysis of every examination (although some believe the time requirements too great).

R–4 Scholarly attitude.

R–5 Thoroughness in daily preparation.

R–6 Sympathy and patience with the student.

R–7 Readiness to adopt new methods of teaching.

R–8 Cooperation with fellow instructors.

W–10 (18) Sixteen believe there is a need for a Summer School for Electrical Engineering Teachers.

T–1 (18) Sixteen endorse wholly or in part a course in pedagogy dealing with the post-adolescent mind.

T–2 (20) Three believe the teaching applicant should already have credit in such a course.

T–3 (17) Four endorse working for a doctor's degree.

T–4 (18) Fourteen endorse a Summer School sponsored, for example, by the Society for the Promotion of Engineering Education.

T–5 (16) Eleven institutions might send representatives.

B–13 (17) Twelve believe there is a need for an organization of electrical engineering teachers.

B–14 (19) Eighteen believe this can be a part of the Society for the Promotion of Engineering Education.

B–15 (19) Thirteen believe, wholly or in part, that there is a need for a code of ethics for electrical engineering students and teachers and the industry.

B–16 (15) Fourteen believe the formulation of such a code could be sponsored by the Society for the Promotion of Engineering Education.

B–19 (17) Five lend some support to a scheme of giving teachers their apprentice training in several different schools, a year in each.

B–20 (16) Eight believe the industries (and particularly the more poorly organized ones) should contribute more toward the development of the electrical engineering teacher.

B–21 (15) Twelve believe the industries have an ethical responsibility in this direction.

B–25 (13) Nine think a collective statement of the qualities of the ideal electrical engineering teacher would help to guide the development of the individual teacher.

P. H. BURKHART, *Chairman*,
F. L. BISHOP,
W. W. COTNER,
M. C. HUGHES,
H. G. JORDAN,
G. O. RANES,
G. F. TRACY,
C. F. SCOTT, *Adviser*.

REPORT OF COMMITTEE NO. 10 ON METHODS OF TEACHING ELECTRICAL ENGINEERING

During the present conference of teachers of electrical engineering, the members of your committee on the above subject have listened with especial interest to the many papers presented dealing wholly or in part with this topic and the discussions which they have provoked.

That there is a wide divergence of opinion among our group as to how the subjects of electrical engineering should be taught might seem to exist upon a casual perusal of these papers and their discussions. However, when the numbers of students handled, the equipment, the number of instructors and principal objectives aimed at by the large variety of institutions represented here are all considered, we find that our ideas, as a group, regarding the teaching of electrical subjects do not vary greatly, but differ in minor details usually on account of difficulties of an outside or institutional nature quite beyond our control.

It would be impossible for your committee to render a comprehensive report on so broad a subject in such a short time, owing to the quantity and excellence of the material at our disposal. We have, however, arrived at several conclusions which we deem of importance and submit herewith for your consideration.

The informal method of lecturing seems to have replaced the older type of formal lectures with apparently very desirable results. Since there exist many good text books, we believe the necessity for the formal lecture has passed and recommend that it be minimized or superseded by the more informal type. Supplementary notes may often be used to advantage.

It is felt that the function of the recitation period should be the correction of student difficulties rather than correction of the student's home work. The symposium method should be used rather than the method of questions and answers. We approve the use of two-hour computing periods for problems of a more formal nature.

While local conditions may modify the value of and the necessity for quiz sections, it is felt that a large proportion of their value lies in discussing the defects revealed with each student promptly. Examination and quiz questions should serve again to direct the student's attention to the principal points covered in the subject.

The solution of a large number of problems seems to be essential to thorough grounding in the fundamentals. These should not only be selected from the texts, but also drawn from the experiences of the instructor whenever possible.

We believe that the methods of grading and apportioning marks should be left to the individual instructor or his department to determine.

We approve the use of carefully chosen demonstrations to supplement class-room work but in no sense to supplant the laboratory work.

A close coordination between theoretical courses and laboratory should be maintained.

The teaching method, "reading for honors," seems to provide a real advantage in handling superior students.

We find that the methods used in teaching laboratory work vary greatly among the many institutions owing to large differences existing in the number of students handled and the equipment available. Many of the methods have been treated by another committee, so that your committee has left this phase for their consideration.

Respectfully submitted,

G. W. WILDER, *Chairman,*
L. FUSSELL,
H. M. CROTHERS,
F. M. MCCLAIN.

OPEN QUESTIONS IN THE TEACHING OF MECHANICS *

BY S. M. WOODWARD

The summer schools on mechanics held at Cornell University and at the University of Wisconsin during the summer of 1927 under the auspices of the S. P. E. E. served to focus attention upon this central and fundamental subject in the engineering curriculum in such a way as to make very conspicuous the great diversity of opinion which exists among engineering teachers as to the proper place and scope of the subject and the best methods of teaching it.

Some eighty teachers, gathered from nearly every state of the Union, attended these two schools last summer. At their conclusion those in attendance were unanimous in their expressions of gratitude to those officials of the Society who had initiated and carried through the novel undertaking.

At the various sessions numerous aspects of mechanics were presented and discussed, but there was not time to reconcile diverse opinions on many questions, nor to deliberate over the various interesting points of view until matured convictions could be reached.

At the conclusion of the Wisconsin school the writer was made chairman of an informal committee to consider the possibility of holding future similar meetings and to canvass the situation as far as might seem desirable to determine the need and demand for future gatherings. In pursuance of this duty we sent out a few months ago a circular letter to some 160 engineering schools making inquiry about the attitude of mechanics teachers toward the matter. Responses have been received from about 40 institutions, evincing deep interest in the subject but evidencing again a wonderful variety of deep-seated opinions.

* Presented at the Conference on Mechanics at the 36th annual meeting of the Society, University of North Carolina, June 26–28, 1928.

From what I have gathered from these letters I shall attempt to present briefly what seem to be some of the important open questions connected with the teaching of mechanics.

First, why should there be so much diversity in different institutions in the amount of time allotted to the subject? Measured by the number of hours devoted to it or the amount of credit attached to it, apparently some schools give twice as much weight to the subject as others. It is recognized that the name mechanics may mean a different thing at one place from what it does at another, that its place in the sequence of studies and its relation to other subjects may vary in such a way as to change naturally the time to be devoted to it, but it does not seem reasonable that there should be so great a variation. No one wishes to impose any dull uniformity in the teaching of mechanics, but on the other hand may we not reasonably ask, "How can so much variation be defended?"

A second question relates to the purposes and objects of teaching mechanics to engineering students. Why do we require all engineers to study mechanics? Obviously, we wish them to know the general content of the subject, but perhaps it is equally obvious that a mere memorized book knowledge of the subject is not sufficient. In addition to acquiring a knowledge of certain facts, we expect students also to obtain from their study of mechanics a power, or ability, or skill, in applying its principles to the solution of practical engineering problems. A satisfactory command of this subject requires not only the memorizing of a certain body of information or knowledge, but also practice in the application of that knowledge. As with other forms of activity, the degree of skill acquired depends upon the amount and kind of practice. For this reason it is customary to make the solution of problems form a part of courses in mechanics. Some teachers may claim also an important purpose to be the general training or development of the mind in processes of logical reasoning, particularly as exemplified by mathematical demonstrations and deductions; others emphasize methods and forms of numerical computation; still others may claim an important object to be to prepare the student to read advanced

treatises in other related subjects by acquainting him with the great variety of terms, symbols, and forms of expression used by different writers. The significance of this last object becomes apparent if we recall for a moment how much variation there is among different authors in treating some subjects—variations in language, in methods of approach, in kinds of explanation, and in the entire point of view. The inexperienced student, who has used but a single textbook in a new subject, seems sometimes unable to get any meaning from the language of another book on the same subject. How far we should go in giving practice in reading various authors is certainly an open question.

The variations in opinion among different teachers regarding the chief objectives of the course in mechanics and their relative importance seem to justify a careful consideration of this question. We have had various discussions of standards for passing mechanics, and the best methods of presenting the subject and many details of class room procedure. But until we have very clearly in mind just what we expect to be accomplished by the course in mechanics is it not rather futile to discuss standards and to compare class room methods? Logically it would seem that the first and most important open question in mechanics is this one of objectives, or results, or purposes for which the course is instituted.

Another question which I wish to suggest for your consideration relates to the general method of treatment of the subject matter of mechanics. We often hear it said that the object of education is not so much to acquire information as to learn where the information can be found when needed. In other words, that what we need is a general comprehensive knowledge of a subject rather than a profound knowledge of details. How far does this theory apply to engineering mechanics? Doubtless something is to be said both for and against it. When we view the amount of material contained in our larger textbooks, and compare it with what knowledge of the details of mechanics the ordinary practicing engineer carries in his head, it is evident that, so far as most of the details are concerned, his knowledge is only of the most vague

and general sort. Again, students are commonly passed in a course on a mark of 70 per cent or some similar grade, showing that it may perhaps be possible to pass and know nothing of a considerable part of the subject matter. Furthermore, some teachers object emphatically to the large textbooks and refuse to use them, apparently opposed utterly to the theory of a diffuse treatment of a widespread amount of material. To meet this situation, is there any merit in the proposal to divide the subject matter of mechanics definitely into two, or perhaps more, classes, the first class to contain the important fundamentals which ought to be mastered by every student, 100 per cent perfect, the other class or classes to contain that material for which a more general knowledge would suffice? Probably some teachers in their daily class room exercises point out and emphasize some things as particularly fundamental and more important on that account than others, but I do not now recall any textbook that systematically makes such a distinction. A person studying at home by himself without the help of a teacher would get from most of our textbooks the idea that everything in the book is equally important to be learned, that it should be all or nothing. We teachers have learned by slow and long experience that we can afford to forget a great part of what we once learned. Would it not be in the interest of efficiency and economy to tell the student from the beginning upon what portions of the subject he should concentrate effort, and particularly what things he should fix permanently in his memory? So I raise this question, ought we to distinguish a certain part of the subject matter under a heading such as minimum essentials, to be learned very completely, and, if so, what should be included in this part?

Another general question is the matter of correlation of mechanics with other subjects both before and after it in the course. A similar question arises in connection with every topic in the engineering curriculum. As student numbers grow and teaching staffs increase there seems to be an inevitable tendency toward more and more specialization in class

room work. Each subject tends to be treated as an individual whole, as though it were in a water-tight compartment by itself. This may have certain advantages, but some of us, at least, think it also has disadvantages, which can be overcome only by conscious and definitely directed efforts.

I find that students still debate the question, as they did many years ago when I was a student, whether calculus is necessary for an engineer. Upon graduation most students are afraid to use calculus, so uncertain are they of their understanding and knowledge of it. I think this condition is due largely to the fact that they have too little practice with it after they complete the course in the department of mathematics. Calculus is a language that must be practiced over years, if it is to become the useful tool in the engineer's kit that it should be. Mechanics is one subject wherein there are abundant and convenient opportunities for such practice. The same thing may be said concerning all the branches of mathematics which have preceded the study of mechanics. The question I wish to put before you is, "Ought we to make a definite concerted effort to bring all these separated subjects together into a unified whole, or shall we proceed as though each could be completed and mastered at its appointed place in the program?"

Many other questions, as well as numerous variations on those mentioned above, doubtless occur to you. These I have mentioned seem so important and fundamental in the teaching of mechanics that it appears desirable to the committee, referred to earlier, to have in 1929 another conference on mechanics, lasting perhaps a week or more, to give a careful, thorough-going consideration to all important aspects of the subject. We neither expect nor desire to reach any unanimous agreement. We should like to produce ultimately a balanced, well-reasoned, complete, and adequate written symposium on at least some of these questions, a symposium which will state all sides of each question fully, fairly, and supported by the best arguments that can be marshalled.

We solicit this afternoon your advice on all aspects of the

matter: whether such a further conference should be held; what questions might most profitably be considered; what would be the best methods of procedure; and in what form the results of the deliberations should be put. I have attempted simply to present and to open the whole matter for your discussion.

MOTIONS ADOPTED AT THIS CONFERENCE ON MECHANICS

1. That a conference on Mechanics be held in 1929 either before or directly after the annual meeting of the S. P. E. E.

2. That this conference on Mechanics be held at the Ohio State University.

3. That a committee of five or more members be appointed of which the Chairman, A. P. Poorman, be a member ex-officio, to arrange for this conference.

THE 1929 SESSION OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS.

BY H. P. HAMMOND

Associate Director of Investigation

The dates for the 1929 session of the Summer School, on mechanical engineering, to be held at Purdue University have now been set and are published so that those who expect to attend may plan accordingly. The session will begin at 9 A.M. on Thursday, June 27, and will end on the afternoon of Thursday, July 18. As previously announced, the entire group of staff and members will be housed in one of the Purdue dormitory units. The total expense for room, meals, and incidentals should not exceed fifty dollars for the three weeks, in addition to the registration fee of ten dollars. Excellent progress has been made in preparing the program for the session and also in securing the necessary funds. Further announcements will be made later concerning the program.

The letter quoted below which has been received from one of the members of the 1928 session on physics gives an idea of the reaction of men who have attended past sessions of the School.

> I look back upon the three weeks at M. I. T. during the past July with a great deal of pleasure and profit not only from that which I obtained during the meetings but also from the outside.
>
> To me the great value in the work the S. P. E. E. is carrying on is in bringing together so many who are doing the same work but under nearly as many varying conditions as there are members present. To discuss the common problems and obtain the different points of attack and methods of solution, and to formulate plans by which a better cooperation may be obtained in giving to the student the necessary information to fit him best for his work of service is extremely valuable. As soon as we teachers become able to dove-tail our work with that of another department, and get away from the petty idea

that "nothing matters except our own particular work" we will have gone a long ways along the path of progress.

The work of such able men as were provided for the sessions to give the instruction was highly valuable. Men of such breadth and vision can not fail to give an inspiration to any gathering.

The special lectures upon research work which were given in the fields of structure of the atom, limits of audibility, and aeronautics can not fail to impress one with the great responsibility which he carries, and to inspire him to his best efforts.

Then too, the opportunity given for visiting those great laboratories with their excellent equipment, can not be overestimated.

I feel that your undertaking is one of the finest things that has been brought forth for the advancement of the cause of education.

NECROLOGY

Charles Allen Wright died October 22, 1928, in Lakewood, Ohio, succumbing after a brave fight to an attack of septic pneumonia following general septicæmia.

Mr. Wright was born in Vicksburg, Mississippi, September 13, 1884. He graduated from Tulane University as Bachelor of Electrical Engineering in 1906 and obtained the degree of E.E. *in absentia* in 1909. After a brief period in the U. S. Engineer Office at Vicksburg and two years in the Testing Department of the General Electric Company of Schenectady, New York, he went as instructor in electrical engineering to the Graduate School of Applied Sciences at Harvard, taking the degree of M.E.E. in 1910. The next five years were spent as telephone engineer with the American Telephone and Telegraph Company at New York. In 1915 Mr. Wright went back to teaching, serving as professor of electrical engineering at Iowa State College, Ames, Ia. (1915–18); Carnegie Institute of Technology, Pittsburgh, Pa. (1918); and Ohio State University, Columbus, Ohio (1918–26). In 1926 he was called to take charge of the radio division of the National Carbon Company Research Laboratories at Cleveland, Ohio, a position he held up to the time of his death.

Mr. Wright's chief technical interests were in the field of communication, first in telephone, later in radio. Possessed of a fine sense of devotion to duty, he was conspicuously successful in positions of responsibility and gave his best efforts to these without stint. In spite of the exacting nature of his immediate duties he yet had sufficient energy and ability to work in other ways for the advancement of his profession. He made numerous contributions to the technical literature. His book, "Telephone Communication" (with A. F. Puchstein) was published in 1925. While at Ohio State University he was in charge of the department of communication and

directed the work of the University radio station WEAO.

He was a member of the Society for the Promotion of Engineering Education, American Institute of Electrical Engineers, and Institute of Radio Engineers. At the time of his death he was a reserve officer in the Signal Corps with the rank of Captain.

ITEMS OF INTEREST

H. P. Hammond, Associate Director of Investigations, represented the Society at the inauguration of Harvey Nathaniel Davis as President of Stevens Institute of Technology on Thursday, November 22, 1928.

F. L. Bishop, Secretary of the Society, was the representative at the inauguration of John Roscoe Turner, as President of the West Virginia University, November 28, 1928.

The Council has selected June 19, 20, 21, and 22, for the 1929 meeting of the Society at The Ohio State University, Columbus, Ohio.

NEW MEMBERS

AMIDON, LEE L., Instructor, West Virginia University, Morgantown, W. Va. C. R. Jones, G. P. Boomsliter.

BRATTIN, CLAUD L., Assistant Professor of Drawing and Design, Michigan State College, East Lansing, Mich. R. K. Steward, L. N. Field.

DAY, HAROLD P. S., Plant Supervisor, Wisconsin Telephone Company, 494, 53d Street, Milwaukee, Wis. J. W. Watson, S. Scrimshaw.

FITZGERALD, THOMAS W., Professor and Head, Department of Electrical Engineering, Georgia School of Technology, Atlanta, Ga. R. S. King, D. P. Savant.

FREY, EMIL A., Professor of Modern Languages, Rensselaer Polytechnic Institute, Troy, N. Y. F. L. Bishop, Nell McKenry.

FROCHT, MAX M., Assistant Professor of Mechanics, Carnegie Institute of Technology, Pittsburgh, Pa. N. C. Riggs, A. H. Blaisdell.

HASTINGS, HUDSON B., Professor of Industrial Engineering, Yale University, New Haven, Conn. P. G. Laurson, W. J. Cox.

HOWARD, DARNLEY, Assistant Professor of Mechanical Engineering, Howard University, Washington, D. C. E. F. Church, H. P. Hammond.

JUSTIN, EDWARD M., Instructor in Mathematics, Case School of Applied Science, Cleveland, Ohio. Chas. S. Howe, T. M. Focke.

LORAH, JAMES R., Assistant Professor of Chemical Engineering, University of Missouri, Columbia, Mo. A. C. Lanier, F. L. Bishop.

O'BANION, ALBERT L., Instructor in Electrical Engineering, Cornell University, Ithaca, N. Y. W. R. Cornell, P. M. Lincoln.

ROWE, JOSEPH E., President, Clarkson Memorial College, Potsdam, N. Y. F. L. Bishop, Nell McKenry.

SPENCER, ROBERT L., Dean of Engineering, University of Delaware, Newark, Del. W. F. Lindell, J. L. Coyle.

STEWART, FREDERICK C., Georgia Institute of Technology, Atlanta, Ga. A. A. Potter, G. A. Young.

TANG, KWAN Y., Instructor in Electrical Engineering, The Ohio State University, Columbus, Ohio. F. C. Caldwell, J. E. Shepardson.

TRACY, GORDON F., Assistant Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. Ed. Bennett, J. R. Price.

COLLEGE NOTES

Tulane University.—Mr. C. W. Ricker, late of the North Carolina State College, has been appointed to a professorship of Electrical Engineering.

Mr. Gilbert H. Dunstan of the State University of Iowa, has been appointed Instructor in Mechanical Drawing and Machine Design.

Dr. C. G. Jaeger, late of the University of Missouri, has been appointed Assistant Professor of Mathematics.

At the summer meeting of the Board of Administrators an appropriation of $50,000.00 was voted for the purpose of making additions to the equipment of the several Engineering Laboratories.

The enrollment for the session 1928–29 is 278.